UNITED STATES DEPARTMENT OF AGRICULTURE.

SECTION OF VEGETABLE PATHOLOGY.

CIRCULAR NO. 8.

# EXPERIMENTS IN THE TREATMENT OF PEAR LEAF-BLIGHT AND THE APPLE POWDERY MILDEW.

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U. S. Department of Agriculture,
Section of Vegetable Pathology,
*Washington, D. C., August* 11, 1889.

Sir: I have the honor to submit herewith a circular on experiments made the present season in the treatment of pear leaf-blight and the apple powdery mildew.

Respectfully,

B. T. Galloway,
*Chief of Section.*

Hon. J. M. Rusk,
*Secretary of Agriculture.*

# EXPERIMENTS IN THE TREATMENT OF PEAR LEAF-BLIGHT AND THE APPLE POWDERY MILDEW.

## I.—INTRODUCTION.

The pear leaf-blight and apple powdery mildew are diseases caused by two species of minute parasitic fungi. These little parasites are plants like their hosts, and like the latter each lives for a certain period, produces bodies analogous to seed, and then dies.

In case of the pear leaf-blight the body or vegetative system of the fungus, consisting of very minute, short, colorless filaments, grows between and through the delicate cells of which the leaf is composed, destroying all the latter with which it comes in contact, and using their nourishment for the building up of its own structure. As a result of this process the leaf shows, here and there on the surface, small, more or less circular, dark brown spots; these rapidly enlarge and by running together soon cause the entire leaf to turn brown and then fall off. Before the latter takes place, however, a close examination of the diseased spots will reveal numerous little black specks; these contain the spores or reproductive bodies of the fungus which escape by rupturing the cuticle of the leaf with which they are covered.

Under proper conditions of moisture and heat the spores germinate, and if this takes place on a pear leaf the germ tube bores its way into the tissues, soon develops into colorless filaments like those already described, and these in turn give rise to more spores.

The spores formed late in the summer live over winter in the fallen leaves, and it is these that infect the young foliage the following spring.

The powdery mildew fungus differs in many respects from the one discussed above. Its vegetative system, instead of growing on the inside of the host is almost wholly external and obtains its nourishment by means of suckers which it sends into the cells of the leaf or stem, as the case may be. It covers the various parts of the plant with a grayish, powdery, meal-like growth; hence the name powdery mildew. The spores or reproductive bodies in this case arise from the white, cobweb-like threads which run over the surface and are borne in chains which appear to the naked eye as minute powdery tufts. The fungus in all probability passes the winter in the form we have described; in fact we

have frequently observed it in early spring, before the leaves appear, on the tips of seedlings which were affected with it the previous season. It is also provided with other means of preserving life; but this does not concern us here.

From this brief account of the two fungi it will be seen that to treat them successfully we must, by the application of some substance to the parts subject to attack, destroy the spores before they germinate, or at least before they can infect the hosts.

Both diseases are wide-spread, and so destructive has the leaf-blight become that of late years many nurserymen have abandoned the culture of pear seedlings on account of it. So far as we know, this is the first attempt to treat the diseases on a large scale, and it is hoped that the results obtained will at least encourage a further trial of the remedies.

## II.—TREATMENT OF PEAR LEAF-BLIGHT.

*Entomosporium maculatum*, Lév.

On the 24th of last May, while visiting the nurseries of Franklin Davis & Co. near Washington, our attention was called to a block of young pear trees, consisting of several varieties, the leaves of which were just beginning to show the first spots of leaf blight. The foreman of the nursery, Mr. J. R. Jennings, informed us that this disease was a most serious one with them, as it attacked both budded trees and seedlings, in many cases completely defoliating the latter before the 1st of July.

As Mr. Jennings had just finished planting something over 50,000 pear seedlings, we suggested that he treat a few hundred of them with a view of determining whether the malady could be held in check by the use of fungicides. Acting under our instructions he accordingly sprayed two rows of French seedlings on the 25th of May, using for the purpose the Bordeaux mixture, prepared as follows:

Six pounds of sulphate of copper was crushed and dissolved in 16 gallons of water; 4 pounds of fresh lime was then slaked in 6 gallons of water, using, of course, another vessel for the purpose. When the two solutions had cooled they were poured into a barrel and thoroughly mixed by means of a long wooden paddle.

Owing to the fact that the French seedlings were the last to be planted, their leaves were just beginning to unfold at the time the application was made. Ten days later, according to Mr. Jennings, the results of the treatment were so plainly beneficial that, after consulting Mr. Davis, he determined to treat the entire block of 50,000 seedlings. This plan was accordingly carried out, the copper being obtained from Baltimore at a cost of 7½ cents per pound.

For applying the mixture, the Japy pump, with the improved Vermorel lance and nozzle, was used, this combination being found to answer the purpose admirably. The pump, together with the lance and nozzle, we

have figured at I. The reservoir *a* holding about 4 gallons of liquid is made of copper and is fastened to the back knapsack fashion by means of the straps *b b*. The piston of the pump works in the cylinder *d*, and is operated by the lever *e*, which works similar to that of a forge bellows. By means of this arrangement and the air chamber *g*, the liquid is forced out in a continuous stream through the nozzle *h*. The lance *i*, being attached to a rubber tube *j*, is easily directed over almost any part of the plant. One other part not mentioned is the "agitator," a perforated brass plate which lies near the bottom of the reservoir and which is moved up and down by the piston-rod, thus keeping the liquid constantly stirred up. With this outfit the 50,000 plants were sprayed in a day and a half.

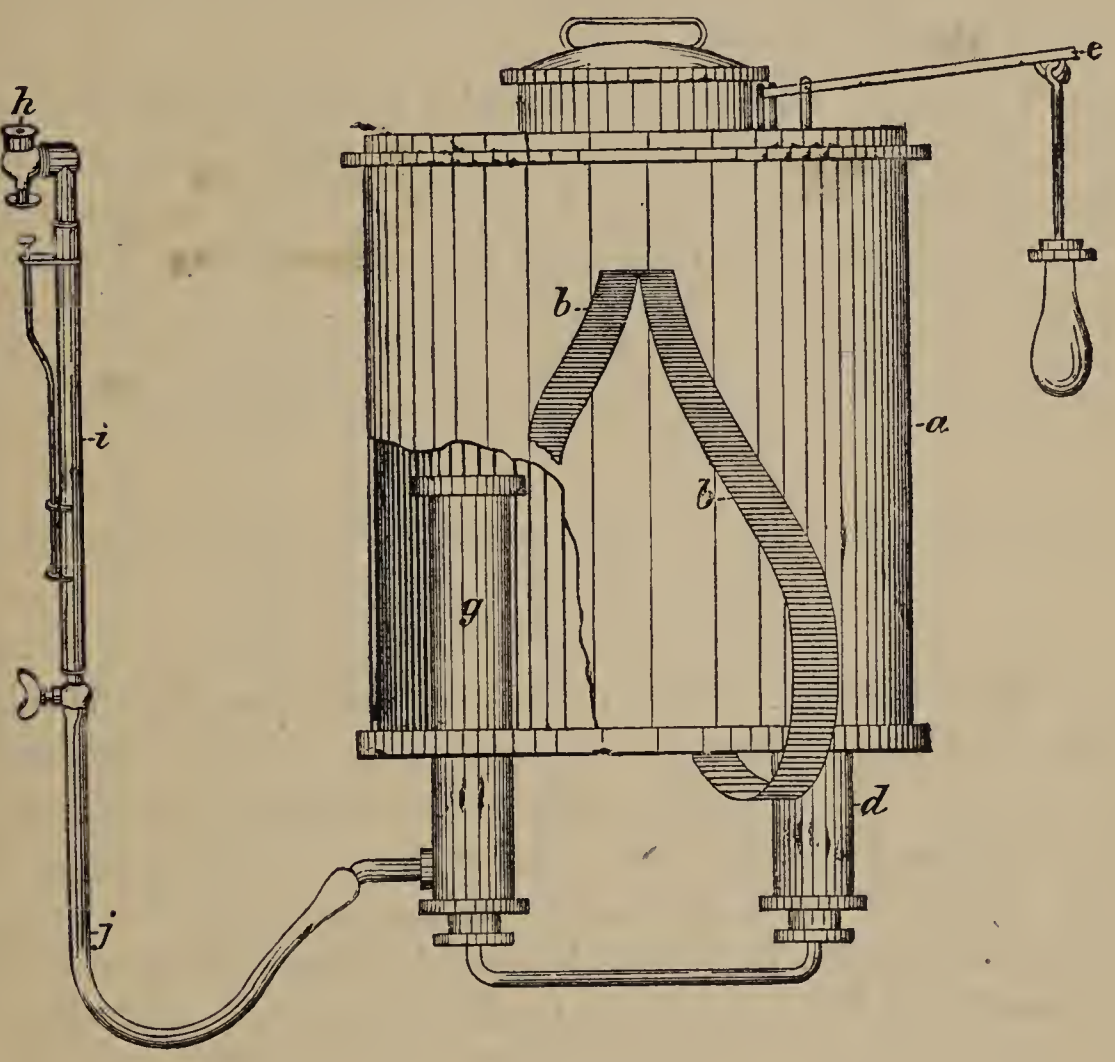


FIG. I.

For a time Japy pumps could only be obtained in France, but recent arrangements have been made for their manufacture here. They are now offered for sale by the Columbia Brass Works, 1216 D street, this city, the retail price of a single machine, such as we have described, being $21. Another pump equally as good as the Japy is the Eureka, manufactured and sold by Adam Weaber, of Vineland, N. J. The cost of the Eureka, complete, is $21.65.

The first general application of the fungicide was made on June 5, and was followed by four others at intervals of ten days. For each application it required 125 gallons of the mixture, and the total cost of each treatment was as follows:

| | |
|---|---|
| Forty pounds copper sulphate, at 7½ cents | $3.00 |
| Thirty-five pounds lime | .25 |
| Labor in preparing and applying mixture | 1.50 |
| Total | 4.75 |

RESULTS OF THE TREATMENT.

When budding began, July 15, the plants, with very few exceptions, were in excellent condition, and have remained so up to the present time. They have retained nearly all their leaves, and since the last spraying, something over a week ago, have made a growth of from five to six inches. Mr. Jennings says that he never saw stocks work better, and he is quite certain that unless something unforseen happens the stand will be almost perfect.

Not three hundred yards from this block of seedlings there are probably 10,000 budded pears of various varieties which have lost nearly all their leaves from blight. These were not sprayed, otherwise they received practically the same treatment as the seedlings. When we take into consideration the fact that budded stocks are less liable to disease than seedlings, it stands to reason that the latter owe their freedom from the malady to the treatment we have discussed above.

## III.—Treatment of the apple powdery mildew.

*Podosphæra oxycanthæ*, (D C), De By.

Early in May last Mr. Davis, of the firm of Franklin, Davis & Co., called upon us for the purpose of ascertaining whether anything could be done to prevent their young apple trees from mildewing. He stated that last year they were unable to bud at least one-third of their stocks on account of this disease, and as it had already appeared among the same plants this season he feared it would destroy them and spread to adjoining seedlings which had not yet developed the first leaves.

On the 13th of May we visited the nurseries and found that the disease had already made considerable headway in a block of budded stocks containing something over 200,000 trees. These were budded last summer, but owing to the mildew only about two-thirds of the buds took. Where the buds did not take the stocks were left standing, and at the time of our visit these were about 2 feet high, while the buds had grown all the way from 6 inches to a foot.

So far as we were able to determine, by a careful examination of the entire block, the fungus was confined almost wholly to the seedlings, and for this reason, together with the fact that budded stocks are rarely, if ever, severely injured by the disease, we suggested that our work be limited to the former. Arrangements were accordingly made for carrying out this plan, and on the afternoon of the 13th the first application was begun.

The preparation used for the purpose was a solution made by dissolving half an ounce of sulphuret of potassium (*liver of sulphur*) to the gallon of water. This was applied with the Japy pump and Raveneau nozzle. It soon became apparent that the Raveneau nozzle would not answer for the work at all, as owing to the width of its spray more than three-fourths of the liquid was wasted on the ground. It also became very evident that the sulphuret of potassium would have to be discarded, as in the evening following our first spraying a heavy rain washed every vestige of it off. Notwithstanding these discouragements, however, Dr. Davis had all the seedlings in the block sprayed, and at our suggestion then postponed further treatment until a new nozzle and another fungicide could be provided. On our return to Washington we experimented with several nozzles, and finally adopted the instrument figured at II. This consists of a Cyclone or Eddy Chamber Nozzle *a*, which by means of the collar *b* is fastened to the lance *c*. It will be seen that the lance is the same as that figured at I, on page 7, and that the Eddy Chamber Nozzle has merely been substituted for the Vermorel. The matter of a suitable nozzle being settled, it remained to decide upon some fungicide which would adhere firmly to the leaves and at the same time not injure them. In this connection it was also necessary to take into consideration the fact that the nozzles we had devised could only be used for clear solutions, such preparations as the Bordeaux mixture being too thick and pasty to pass through the small apertures. The good results attending our experiments in 1888 in the treatment of grape diseases with the ammoniacal carbonate of copper solution finally induced us to try it as a remedy against the apple powdery mildew.

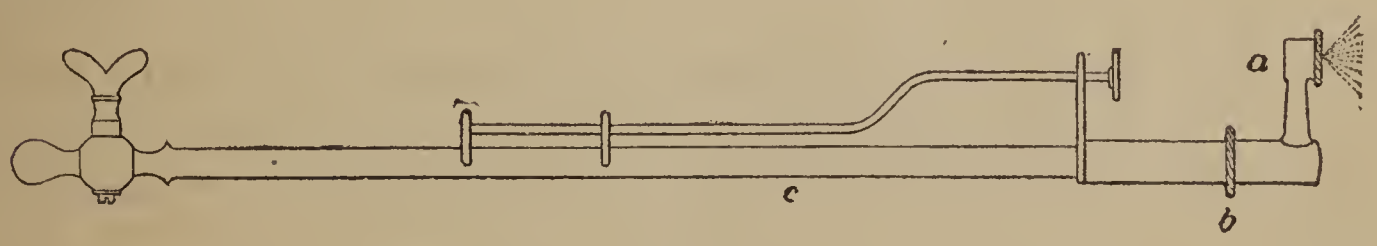


FIG. II.

Another pump, a Vermorel, provided with a lance and Eddy Chamber Nozzle, was sent down to the nurseries on May 24, and the first application of the ammoniacal carbonate of copper solution was then begun.

The nozzles were found to answer the purpose admirably, the spray being just wide enough to cover the small trees without any waste whatever. The spray, moreover, was exceedingly fine, and as the lance attachment enabled the operator to hold the nozzle down among the leaves there was no inconvenience arising from the wind, deflecting the spray and blowing it back on the man.

A part of the block which had already been sprayed with the liver of sulphur was first treated. The block consisted of 50 rows of 1,000 trees each, running east and west.

To facilitate the work of spraying, three barrels were placed in a road at the east end of the block, the first at the south side, the second in the middle, and the third at the north side. Everything being in readiness, the barrels having previously been filled with water (44 gallons), 6 ounces of carbonate of copper was weighed out and placed in an ordinary water-pail.* A half gallon of ammonia was then slowly added, at the same time a complete mixture was effected by stirring with a wooden paddle. Two minutes' stirring was sufficient to completely dissolve the copper, and the solution, which is of a beautiful blue color, was then poured into the central barrel and mixed with the water by means of a long stick. A moment's stirring and the solution, which was now of a light blue color, was ready for use.

The operators now strapped the pumps on their backs, this being an easy task when the latter are empty, and proceeded to fill them; this was accomplished by the man standing with his back to the barrel and resting the bottom edge of the reservoir upon it while the second man proceeded to fill the latter by means of a tin pail. In this way the two reservoirs were filled in less than a minute, each man assisting the other. The men began spraying at 10.30 a. m., and at 3 p. m. had sprayed 30,000 trees, having rested an hour at noon. For this work it required 22 gallons of the solution.

Summing up the total cost of spraying 30,000 trees, averaging a foot to a foot and a half in height, we have the following:

| | |
|---|---|
| Three ounces carbonate of copper | $0.10 |
| One-half gallon ammonia | .09 |
| Labor of two men, three and a half hours each, 7½ cents per hour | .52½ |
| Labor in preparing mixture | .10 |
| Total | .79½ |

It will be seen from the above that the total cost per 1,000 trees for each application is something over 2½ cents. The fact is, however, as was determined by further calculation, the cost per 1,000 trees was about 2 cents.

The block of young trees, which we have already mentioned as containing 200,000, two-thirds of which are budded stocks, was sprayed twice, at a total cost of $8. Two other blocks containing 150,000 and 40,000 seedlings, respectively, were sprayed six times, at a total cost of $22.80.

## RESULTS OF THE TREATMENT.

At this writing (August 11) there is practically no mildew on any of the trees in the block of 200,000, and the large seedlings in which the buds did not take last year, on account of the mildew, were budded this season without difficulty. Of the 190,000 remaining stocks all worked well excepting about 60,000, which were purchased in Ohio and which

* The carbonate of copper is in the form of a very fine powder, consequently is quite readily handled by means of a small tin scoop.

were affected with mildew at the time of planting. We were present when these seedlings were unpacked, and a careful examination of many of them revealed a thick coating of mildew on their tips, where it had no doubt passed the winter. Notwithstanding this, these stocks are now doing fairly well and probably not more than three per cent. of their buds will be lost.

On the whole the entire 390,000 trees are doing exceedingly well, and Mr. Jennings is confident that this is largely due to the treatment, which, here let me add, was, after the first spraying, left entirely in his charge and was carried out faithfully in every particular.

The mildew is present and is doing considerable damage on many of the unsprayed trees in the nursery. Cherries, especially, are badly affected, as well as several varieties of plums. It might be well to add here that this fungus attacks the peach, plum, shadbush, hawthorne, and several other allied plants, but whether the spores from these plants have the power of infecting the apple, or *vice versa*, has not, so far as we know, been proved.